

## What is claimed is:

**[Claim 1]** 1. A firetrain for a safe and arm device having a safe position and an armed position, the firetrain comprising:

an input explosive column having a longitudinal axis;

a transfer charge having a longitudinal axis and first and second ends and movable from a safe position to an armed position;

a receptor charge having a longitudinal axis that is non-collinear with and substantially parallel to the longitudinal axis of the input explosive column;

wherein, in the safe position, the transfer charge is remote from both the input explosive column and the receptor charge; and

wherein, in the armed position, the input explosive column is adjacent the first end of the transfer charge to thereby initiate the transfer charge, the

longitudinal axis of the input explosive column is substantially perpendicular to the longitudinal axis of the transfer charge, the second end of the transfer charge is adjacent the receptor charge to thereby initiate the receptor charge and the longitudinal axis of the receptor charge is substantially perpendicular to the longitudinal axis of the transfer charge.

**[Claim 2]** 2. The firetrain of claim 1 wherein a total volume of explosives in the input explosive column, the transfer charge and the receptor charge is less than about 0.002 cubic centimeters.

**[Claim 3]** 3. The firetrain of claim 1 wherein a total volume of explosives in the input explosive column and the transfer charge is less than about 0.0012 cubic centimeters.

**[Claim 4]** 4. The firetrain of claim 1 wherein a total volume of explosives in the input explosive column is less than about 0.001 cubic centimeters.

**[Claim 5]** 5. The firetrain of claim 1 wherein the transfer charge consists of secondary explosives.

**[Claim 6]** 6. The firetrain of claim 1 wherein the receptor charge consists of secondary explosives.

**[Claim 7]** 7. The firetrain of claim 1 wherein the input explosive column comprises first, second and third charges, the first charge initiating the second charge, the second charge initiating the third charge and the third charge initiating the transfer charge.

**[Claim 8]** 8. The firetrain of claim 7 wherein the first charge consists of primary explosive, the second charge consists of primary explosive and the third charge consists of secondary explosive.

**[Claim 9]** 9. The firetrain of claim 1 further comprising:  
a spot charge disposed adjacent the input explosive column, for initiating the input explosive column;  
an initiator chip disposed adjacent the spot charge, for initiating the spot charge; and  
an output charge disposed adjacent the receptor charge, the receptor charge initiating the output charge.

**[Claim 10]** 10. A safe and arm assembly, comprising:  
the firetrain of claim 9;  
a base assembly having the output charge and a first portion of the receptor charge disposed therein;  
a safe and arm device layer disposed atop the base assembly, the safe and arm device layer including an arming mechanism movable between a safe position and an armed position, the transfer charge being disposed in the arming

mechanism and a second portion of the receptor charge being disposed in the safe and arm device layer;  
a cover plate assembly disposed atop the safe and arm device layer and having the input explosive column disposed therein; and  
an initiator board assembly disposed atop the cover plate assembly and having the spot charge and the initiator chip disposed therein.

**[Claim 11]** 11. The safe and arm assembly of claim 10 wherein a total volume of explosives in the input explosive column, the transfer charge and the receptor charge is less than about 0.002 cubic centimeters.

**[Claim 12]** 12. The safe and arm assembly of claim 10 wherein a total volume of explosives in the input explosive column and the transfer charge is less than about 0.0012 cubic centimeters.

**[Claim 13]** 13. The safe and arm assembly of claim 10 wherein a total volume of explosives in the input explosive column is less than about 0.001 cubic centimeters.

**[Claim 14]** 14. The safe and arm assembly of claim 10 wherein the transfer charge consists of secondary explosives.

**[Claim 15]** 15. The safe and arm assembly of claim 10 wherein the receptor charge consists of secondary explosives.

**[Claim 16]** 16. The safe and arm assembly of claim 10 wherein the input explosive column comprises first, second and third charges, the first charge initiating the second charge, the second charge initiating the third charge and the third charge initiating the transfer charge.

**[Claim 17]** 17. The safe and arm assembly of claim 16 wherein the first charge consists of primary explosive, the second charge consists of primary explosive and the third charge consists of secondary explosive.

**[Claim 18]** 18. A firetrain for a safe and arm device having a safe position and an armed position, the firetrain comprising:

an input explosive column having a longitudinal axis;

an input charge having a longitudinal axis and first and second ends, the input explosive column being substantially perpendicular to and adjacent the first end of the input charge;

a transfer charge having a longitudinal axis and first and second ends and movable from a safe position to an armed position;

a receptor charge having a longitudinal axis that is substantially collinear with the longitudinal axis of the input charge;

wherein, in the safe position, the transfer charge is remote from both the input charge and the receptor charge; and

wherein, in the armed position, the second end of the input charge is adjacent the first end of the transfer charge to thereby initiate the transfer charge, the longitudinal axis of the input charge is substantially collinear with the longitudinal axis of the transfer charge, the second end of the transfer charge is adjacent the receptor charge to thereby initiate the receptor charge and the longitudinal axis of the receptor charge is substantially collinear with the longitudinal axis of the transfer charge.

**[Claim 19]** 19. The firetrain of claim 18 wherein the input charge, transfer charge and receptor charge are substantially a same size.

**[Claim 20]** 20. The firetrain of claim 18 wherein the transfer charge consists of secondary explosives.

[Claim 21] 21. The firetrain of claim 18 wherein the receptor charge consists of secondary explosives.

[Claim 22] 22. The firetrain of claim 18 wherein the input explosive column comprises first, second and third charges, the first charge initiating the second charge, the second charge initiating the third charge and the third charge initiating the input charge.

[Claim 23] 23. The firetrain of claim 22 wherein the first charge consists of primary explosive, the second charge consists of primary explosive and the third charge consists of secondary explosive.

[Claim 24] 24. The firetrain of claim 18 further comprising:  
a spot charge disposed adjacent the input explosive column, for initiating the input explosive column;  
an initiator chip disposed adjacent the spot charge, for initiating the spot charge; and  
an output charge disposed adjacent the receptor charge, the receptor charge initiating the output charge.

[Claim 25] 25. A safe and arm assembly, comprising:  
the firetrain of claim 24;  
a base assembly;  
a safe and arm device layer disposed atop the base assembly, the safe and arm device layer including an arming mechanism movable between a safe position and an armed position, the transfer charge being disposed in the arming mechanism and the input charge and receptor charge being disposed in the safe and arm device layer;  
a cover plate assembly disposed atop the safe and arm device layer and having the input explosive column disposed therein; and

an initiator board assembly disposed atop the cover plate assembly and having the spot charge and the initiator chip disposed therein.

**[Claim 26]** 26. A firetrain for a safe and arm device having a safe position and an armed position, the firetrain comprising:

an input explosive column having a longitudinal axis;

an input charge having a longitudinal axis and first and second ends, the input explosive column being substantially perpendicular to and adjacent the first end of the input charge;

a transfer charge having a longitudinal axis and first and second ends and movable from a safe position to an armed position;

a receptor charge having a longitudinal axis that is substantially collinear with the longitudinal axis of the input charge;

wherein, in the safe position, the transfer charge is remote from both the input charge and the receptor charge; and

wherein, in the armed position, the second end of the input charge overlaps the first end of the transfer charge to thereby initiate the transfer charge, the longitudinal axis of the input charge is substantially parallel to the longitudinal axis of the transfer charge, the receptor charge overlaps the second end of the transfer charge to thereby initiate the receptor charge and the longitudinal axis of the receptor charge is substantially parallel with the longitudinal axis of the transfer charge.

**[Claim 27]** 27. The firetrain of claim 26 further comprising:

a spot charge disposed adjacent the input explosive column, for initiating the input explosive column;

an initiator chip disposed adjacent the spot charge, for initiating the spot charge; and

an output charge disposed adjacent the receptor charge, the receptor charge initiating the output charge.

**[Claim 28]** 28. A safe and arm assembly, comprising:

the firetrain of claim 27;

a base assembly having the output charge disposed therein;

a safe and arm device layer disposed atop the base assembly, the safe and arm device layer including an arming mechanism movable between a safe position and an armed position, the transfer charge being disposed in the arming mechanism;

a cover plate assembly disposed atop the safe and arm device layer and having the input explosive column, the input charge and receptor charge disposed therein; and

an initiator board assembly disposed atop the cover plate assembly and having the spot charge and the initiator chip disposed therein.

**[Claim 29]** 29. A firetrain for a safe and arm device having a safe position and an armed position, the firetrain comprising:

an input explosive row having a longitudinal axis;

a transfer charge having a longitudinal axis and first and second ends and movable from a safe position to an armed position;

a receptor charge having a longitudinal axis that is substantially collinear with the longitudinal axis of the input explosive row;

wherein, in the safe position, the transfer charge is remote from both the input explosive row and the receptor charge; and

wherein, in the armed position, the input explosive row is adjacent the first end of the transfer charge to thereby initiate the transfer charge, the longitudinal axis of the input explosive row is substantially collinear with the longitudinal axis of the transfer charge, the second end of the transfer charge is adjacent the receptor charge to thereby initiate the receptor charge and the longitudinal axis of the transfer charge is substantially collinear with the longitudinal axis of the receptor charge.

**[Claim 30]** 30. The firetrain of claim 29 wherein the transfer charge consists of secondary explosives.

[Claim 31] 31. The firetrain of claim 29 wherein the receptor charge consists of secondary explosives.

[Claim 32] 32. The firetrain of claim 29 wherein the input explosive row comprises first, second and third charges, the first charge initiating the second charge, the second charge initiating the third charge and the third charge initiating the transfer charge.

[Claim 33] 33. The firetrain of claim 32 wherein the first charge consists of primary explosive, the second charge consists of primary explosive and the third charge consists of secondary explosive.

[Claim 34] 34. The firetrain of claim 29 further comprising:  
a spot charge disposed adjacent and perpendicular to the input explosive row, for initiating the input explosive row;  
an initiator chip disposed adjacent the spot charge, for initiating the spot charge; and  
an output charge disposed adjacent the receptor charge, the receptor charge initiating the output charge.

[Claim 35] 35. A safe and arm assembly, comprising:  
the firetrain of claim 34;  
an output housing that contains the output charge;  
a safe and arm device layer disposed in the output housing, the safe and arm device layer including an arming mechanism movable between a safe position and an armed position, the transfer charge being disposed in the arming mechanism, the input explosive row and the receptor charge being disposed in the safe and arm device layer; and an initiator board assembly disposed atop the safe and arm device layer and having the spot charge and the initiator chip disposed therein.



